

Documentation:

Example Sea Level Rise Inundation Maps

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Purpose

This document describes the methods used to create the set of attached maps of select Estuary and Salmon Restoration Program (ESRP) project sites. Guidelines for mapping sea level rise inundation can be found in Norheim et al. (2018).

List of Maps

A series of 10 maps were created for each project site (**Table 1**). The following sections describe the project sites that were mapped, along with the elevation data, relative sea level rise (RSLR) projections, and storm surge estimates used to generate the maps. The baseline map simply shows a satellite image of the site without any additional layers; subsequent inundation layers are semi-transparent so that users can more easily orient themselves based on specific features on the landscape.

#	Year	RSLR Projection	Water Elevation
0	N/A (baseline map)		
1	Current	N/A	MHHW
2	Current	N/A	MHHW + 2-year Surge
3	Current	N/A	MHHW + 100-year Surge
4	2050	83% and 17% (RCP 8.5)	MHHW + RSLR
5	2050	83% and 17% (RCP 8.5)	MHHW + RSLR + 2-year Surge
6	2050	83% and 17% (RCP 8.5)	MHHW + RSLR + 100-year Surge
7	2120	5% (RCP 4.5) and 1% (RCP 8.5)	MHHW + RSLR
8	2120	5% (RCP 4.5) and 1% (RCP 8.5)	MHHW + RSLR + 2-year Surge
9	2120	5% (RCP 4.5) and 1% (RCP 8.5)	MHHW + RSLR + 100-year Surge

Table 1. List of maps included in the attached examples.

Project Sites

These maps were produced in collaboration with the Washington Department of Fish and Wildlife's Estuary and Salmon Restoration Program (ESRP). We considered five project sites for mapping. These are listed below, along with links to the Washington State Recreation Office's PProject Information System (PRISM) page for more information on each project.

1. **Dockton.** On Maury Island, this site is part of a larger restoration effort within Quartermaster Harbor. The proposed project involves property acquisitions and the removal of shoreline armoring. [PRISM Project #16-2122](#).

2. **Fir Island.** Located in the south end of Skagit bay, this project involves setting back existing coastal dikes and restoring about 130 acres of tidal estuary. The project is near completion. [PRISM Project #14-1022](#).
3. **Kilisut.** On the harbor between Indian and Marrowstone Islands in Puget Sound. This project involves replacing two culverts with a bridge. It is currently in the construction phase. [PRISM Project #14-1366](#).
4. **Leque Island.** Located just west of Stanwood, this project involves restoration and levee removal for 250 acres on Leque island. Phase 1 of the project has been completed, with Phase 2 planned for 2019. [PRISM Project #16-1318](#).
5. **Tahuya.** Located on the Tahuya River delta on the southern end of the Kitsap Peninsula. The project would replace an existing bridge with one that spans the estuary. It is currently in the planning phase. [PRISM Project #16-2130](#).

This directory includes maps for the Dockton, Kilisut, and Tahuya sites. To show the broader context for restoration at the Dockton site, we also included a map of that captures the corresponding “Shoreline Process Unit” which are defined based on sediment transport processes (Simenstad et al., 2011). We did not produce maps for Fir Island or Leque because existing elevation datasets do not capture the changes in the topography of the sites due to regrading, channel restoration, and the construction of new setback dikes. As a result, it was not possible for us to create accurate maps of current and future inundation.

Elevation Data

Land elevations were obtained from lidar surveys available on the [Washington Department of Natural Resource’s \(WA DNR\) Lidar Portal](#) website (**Table 2**). High tide elevation – specifically, the elevation of Mean Higher High Water (MHHW) – was obtained using the NOAA [VDatum](#) tool. All data were referenced to NAVD88.

Project Site	Lidar Dataset	Elevation of MHHW (ft)
Dockton	Dockton 2012	9.2
Maury Island	King County 2016	9.2
Kilisut	Puget Lowlands 2005	7.9
Tahuya	Puget Lowlands 2005	9.0

Table 2. Land and water elevation data used as a baseline for these maps. Tidal elevations are referenced to NAVD88. *Source: WA DNR Lidar Portal, and NOAA Tides and Currents website.*

Sea Level Rise Projections

We obtained relative sea level rise (RSLR) projections from the Washington State [Coastal Hazards Resilience Network](#) website. The projections are described by Miller et al. (2018).

Since restoration priorities include both short-term and long-term recovery, we produced maps for two different time frames – 2050 and 2120 – corresponding to about 30 years and 100 years from today, respectively (**Table 3**). For the near-term projections, we considered the likely range among projections, corresponding to the 83% and 17% probability levels – corresponding to the most likely projections for 2050. Up until about 2050, the differences among greenhouse gas scenarios are minor (Mauger et al., 2015). As a result, these near-term projections are based on the high-end RCP 8.5 scenario. For the long-term projections, we selected high-end probability levels of 5% and 1%. This more conservative (high-end) assessment of risk is intended to apply to both restoration planning and infrastructure design, assuming a 100-year lifetime. In both applications, the high-end projections are used to minimize the risk of under-design. In order to bracket the high end of these projections, the 5% projection is based on the low-end RCP 4.5 scenario, while the 1% projection is taken from the high-end RCP 8.5 scenario.

Year	Probability	Scenario	Relative Sea Level Rise (ft)		
			Dockton	Kilisut	Tahuya
2050	83%	RCP 8.5 (High)	0.6	0.6	0.5
	17%	RCP 8.5 (High)	1.1	1.0	1.1
2120	5%	RCP 4.5 (Low)	4.2	4.1	3.9
	1%	RCP 8.5 (High)	7.0	6.9	6.6

Table 3. Relative sea level rise (RSLR) projections used in the attached maps. *Source: Miller et al. (2018).*

It is important to note that these are only a subset of a wide range of sea level rise projections, which span from 2010 to 2150, across two greenhouse gas scenarios, and probabilities ranging from 99% to 0.1%. Different choices may be more appropriate for use with these and with other projects, depending on the specific needs and priorities of project managers or decision makers. These choices will result in changes to the sea level rise inundation maps.

Storm Surge

A forthcoming report will provide detailed storm surge projections for all of Washington’s coastlines (Miller et al., 2019). For the current maps, we have simply used the storm surge anomalies (difference between observed and predicted tide) from the [Seattle tide gauge](#) (**Table 4**). As described in Norheim et al. (2018), these do not vary significantly within Puget Sound and are therefore a good approximation to use until the Miller et al. (2019) report becomes available.

Return Interval	Storm Surge Anomaly (ft)
2-year	2.3
10-year	2.8
100-year	3.2

Table 4. Storm surge anomalies used in the attached maps.
Source: NOAA Tides and Currents website.

These storm surge numbers do not include waves. *This means that the resulting inundation maps are likely to underestimate the potential for flooding during storm events.* In areas where waves do not play a large role in coastal flooding, this effect will be minor. However, in areas that where wave action is an important driver of flood risk, the current maps could significantly underrepresent the extent and depth of flooding.

References

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